

Ethanol as a Fuel Component: Effect on Aerosol Composition

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Methyl-tert-butylether (MTBE) has been added to gasoline as an oxygen source to promote cleaner burning, reducing air pollution. However, it is being phased out in many U.S. states because it contaminates groundwater. Ethanol is now being substituted as a cheap oxygen additive and renewable fuel, yet its effects on the environment and human health have not been sufficiently explored. Ethanol has a high vapor pressure and therefore significant evaporative emissions, leading to elevated levels in the air. High ethanol concentrations have been observed in Sao Paulo, Brazil (~180 parts per billion, ppb), where ethanol is a primary fuel source, in contrast with other cities (~8 ppb in Tokyo). Reaction of ethanol in or on acidic particles could result in products more toxic than the reactants, but whether such reactions take place under atmospheric conditions is unknown. With a lifetime of several days, ethanol emissions could also affect the remote atmosphere, including acidic aerosols. Physical and chemical interactions with aerosol particles could alter cloud formation and thus, indirectly, climate. Organic material has been detected in most sulfate particles in the atmosphere (at 5-15 km), the source of which has yet to be identified. We aim to characterize the interaction of ethanol with sulfate particles by evaluating ethanol solubility and reactivity in sulfuric acid solutions. Results indicate that ethanol vapor is extremely soluble in low-temperature aqueous sulfuric acid. Measured Henry's law constants are 10^4 - 10^7 M atm⁻¹ over ranges of temperature (210-240 K) and acid composition (40-70 weight % H₂SO₄) common to the upper troposphere and lower stratosphere. However, solubility alone does not account for the organic fraction in sulfate particles, and possible cross-reactions of organic compounds are being assessed.